GEOLOGY OF THE SAND CANYON-
SOLEDAD CANYON AREA

REPORT BY

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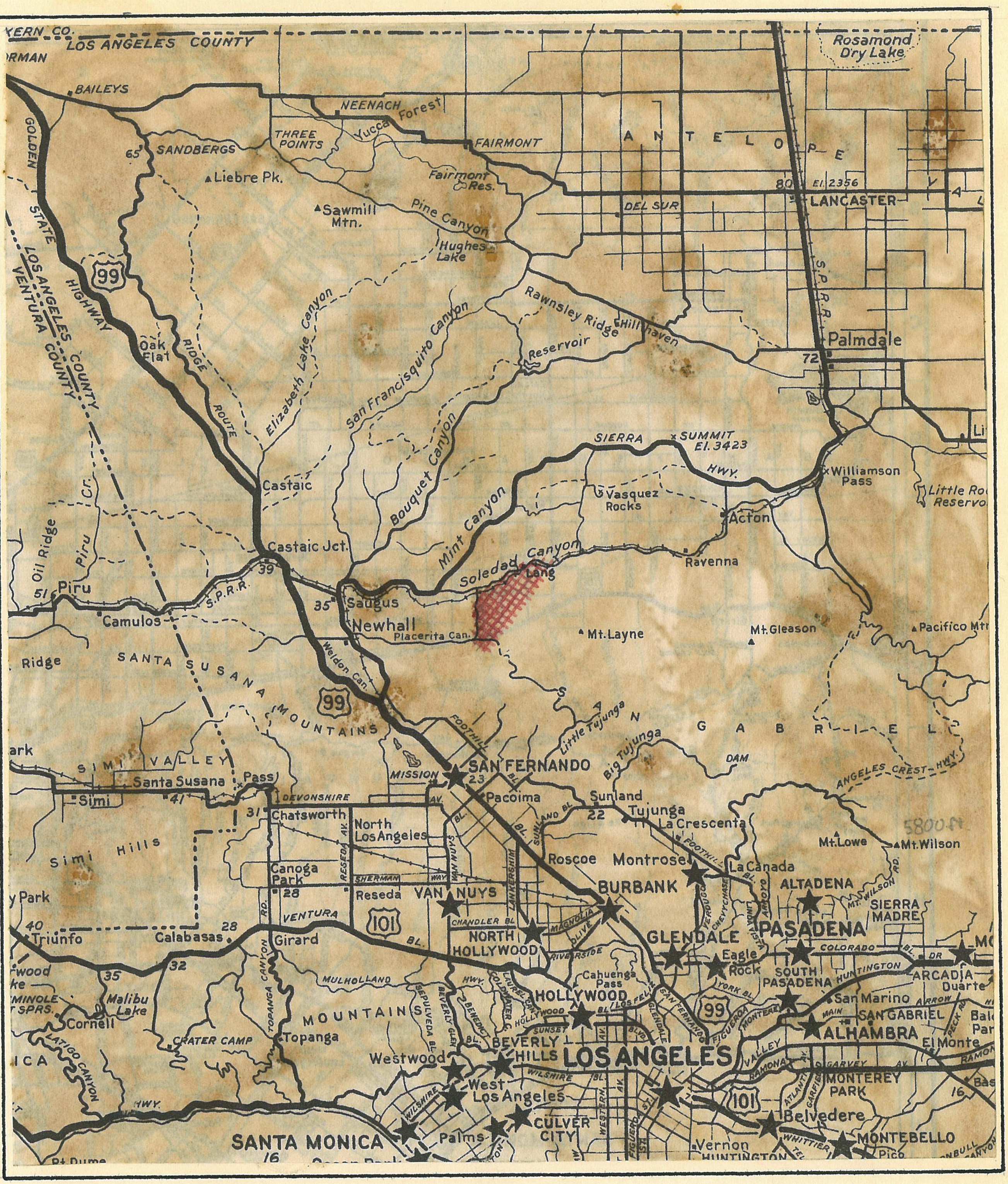


KERN CO.
LOS ANGELES COUNTY
Rosamond Dry Lake
BAILEYS
NEENACH
Yucca Forest
THREE POINTS
SANDBERGS
FAIRMONT
ANTELOPE VALLEY
Liebre Pk.
Fairmont Res.
El. 2356
LANCASTER
Sawmill Mtn.
Pine Canyon
DEL SUR
Hughes Lake
GOLDEN STATE HIGHWAY
LOS ANGELES COUNTY
VENTURA COUNTY
99
Rawnsley Ridge
Hillhaven
S.P.R.R.
Palmdale
Oak Flat
RIDGE ROUTE
Elizabeth Lake Canyon
San Francisquito Canyon
Reservoir
Bouquet Canyon
SIERRA HWY.
SUMMIT El. 3423
Williamson Pass
Little Rock Reservoir
Castaic
Vasquez Rocks
Acton
Mint Canyon
Oil Ridge
Piru Cr.
Castaic Jct.
Soledad Canyon
Lang
Ravenna
Piru
S.P.R.R.
Saugus
Newhall
Placerita Can.
Camulos
Mt. Layne
Mt. Gleason
Pacifico Mtn.
Ridge
SANTA SUSANA MOUNTAINS
Weldon Can.
SAN GABRIEL
FOOTHILL
Little Tujunga
Big Tujunga
DAM
ANGELES CREST HWY.
SIMI VALLEY
MISSION
SAN FERNANDO
Santa Susana Pass
Simi
DEVONSHIRE
Pacoima
Sunland
Tujunga
La Crescenta
Chatsworth
North Los Angeles
Mt. Lowe
Mt. Wilson
5800 ft.
Simi Hills
Canoga Park
RESEDA
SHERMAN WAY
Roscoe
Montrose
La Canada
ALTADENA
Reseda
VAN NUYS
BURBANK
SIERRA MADRE
Park
Triunfo
Calabasas
VENTURA BL.
101
CHANDLER BL.
NORTH HOLLYWOOD
MAGNOLIA
RIVERSIDE
GLENDALE
PASADENA
Girard
Eagle Rock
COLORADO BL.
Malibu Lake
MULHOLLAND HWY.
Cahuenga Pass
SOUTH PASADENA
HUNTINGTON DR.
ARCADIA
Duarte
Cornell
MOUNTAINS
HOLLYWOOD
99
San Marino
SAN GABRIEL
CRATER CAMP
Topanga
TOPANGA CANYON
LATIGO CANYON
SUNSET
ALHAMBRA
El Monte
Westwood
BEVERLY HILLS
LOS ANGELES
VALLEY
RAMONA
GARVEY
West Los Angeles
WILSHIRE
MONTEREY PARK
101
HWY.
Belvedere
CULVER CITY
Palms
SANTA MONICA
16
Vernon
HUNTINGTON
MONTEBELLO
Pico
Pt. Dume

I. INTRODUCTION

A. Location and Size of Area

The region under consideration is known as the Sand Canyon-Soledad Canyon Area. It is situated about 7.8 miles to the east of the town of Saugus, and its easternmost boundary is near the station of Lang. It lies on the north-east slope of the western end of the San Gabriel Mountains.

It is bounded on the north by Soledad Canyon, on the west by Sand Canyon and its tributary Gorman Canyon, and on the south-east by a line which is in a direction of S 26° W and passes approximately .5 miles east of Lang. The landmarks used are taken from the U.S.G.S. Humphreys, Lang, Sylmar, and Little Tujunga Quadrangle Maps.

The area is roughly triangular in shape, and covers an area of approximately 5 square miles.

B. Purpose of Investigation

The investigation was carried out in conformity with the requirements for the Senior Thesis, Ge 22, for the B.S. degree of the California Institute of Technology. The work was done in the spring of 1939.

C. Method of Investigation

Mapping was done on a topographic map, formed from the SE corner of the U.S.G.S. Humphreys Quadrangle Map, the NE corner of the U.S.G.S. Sylmar Quadrangle Map, the SW corner of the U.S.G.S. Lang Quadrangle Map, and the NW corner of the U.S.G.S. Little Tujunga Quadrangle Map. A Burton Compass was the chief instrument used in mapping and plotting the geoplgic information, while a Tycos Altimeter was of secondary value.

Contacts were traced and plotted directly on a map while in the field. Dips, strikes, and details of the geology were carefully written in a field book, with corresponding numbers to these placed on the field map. The dips, strikes, and details were later transferred to the report map.

D. Acknowledgements

The author is indebted to Dr. John H. Maxson for his constructive criticism of the work and for the identification of some formations. John A. Battle, whose area lies immediately adjacent on the west side of Sand Canyon, also offered valuable advice.

The U.S.G.S. Bulletin 753, by William S. Kew, also proved helpful.

II. SUMMARY AND ECONOMIC CONSIDERATIONS

The area in which work was carried out lies on the north-east slope near the western end of the San Gabriel Mountains, in the vicinity of Lang: south of Soledad Canyon and east of Sand Canyon.

The area rises to the south-east on a fairly gentle slope, with a more rugged topography at the extreme south-eastern border of the area. The change in elevation is from 1550' at the alluvium floor of the intersection of Sand and Soledad Canyons, to 2457' on a high peak, which is located near the S.E. border in township 19.

The drainage takes place in several major canyons which trend north-westward to either Soledad Canyon or Sand Canyon. Sand Canyon drains northward into Soledad Canyon. The drainage from Soledad Canyon is westward via the Santa Clara River, approximately 40 miles to the Pacific Ocean.

The sedimentary rocks in the area are of Middle and Late Tertiary, and Recent. Representing the Upper Miocene is the non-marine Mint Canyon formation, composed of fine and coarse grained sandstones, some heavy conglomerates, caliche beds, soft silt stones, and some tuffaceous materials. Fine grained sandstones and coarse silt stones seem to predominate Representing late Pleistocene are two sets of Terrace gravels. One type is of coarse sandy material carrying pebbles from 2-3 inches in diameter along bedding planes and is rather well stratified. The other type is of very coarse conglomerates, invariably stained by limonite and being extremely resistant. A distinct nonconformity exists between the gravels and the Mint Canyon formation. Nowhere are the two gravels seen in contact with each other. The thickness of the Mint Canyon formation exposed in the area is about 3000 feet, and the thickness of the Terrace gravels nowhere exceeds 120 feet.

The metamorphic rocks of the area are mainly schists, intruded by granites. The schists are presumably a part of the Pelona schists of pre-Jurassic age, while the intrusive is probably Sierran, having formed in late Jurassic. Recent alluvium forms the gentle valleys and the stream floors of the area.

The dominant structural feature of the area is the NE-SW striking fault that makes the contact between the metamorphic and the sedimentary rocks. This fault is about four miles long, with the S.E. side thrust up with respect to the west. It is a normal fault. The Mint Canyon formation has a rather uniform north-westerly dip, and has a somewhat monoclinal structure. In the vicinity of Gorman Canyon, the structure is more complex, there being several interesting fault systems.

The area is practically void of workable mineral resources. There is no structure present which would lead to the suspicion of oil traps below the Mint Canyon formation, except for the possibility of occurrence along the fault.

The basement-complex offers the greatest possibility for exploitation, inasmuch as it is quite rich in ilmenite and iron ores.

III. PHYSICAL CONDITIONS

A. Relief and Elevations

The general relief of the area is mildly moderate, but toward the southeastern boundary assumes a more rugged aspect. Starting at the intersection of Sand and Sòledad Canyons, are a series of low-lying SE-NW trending ridges. Between several of these ridges are broad smooth valley floors, that dip gently to the north west. At the heads of the ridges is a SW-NE striking trough, that marks the division between the Tertiary sediments and the igneous-metamorphic rocks of Jurassic and pre-Jurassic time. Immediately adjacent to the trough and on the S.E. side of it the metamorphic and igneous rocks rise very abruptly. and are quite rugged. The low-lying ridges rise from 1600' in the NW to a maximum of 2457' in the SE. The trough is a minimum of 50' below the adjacent members, and at the NE end is 400' lower than the NW wall. The Mesozoic rocks rise up to about 2800' within about one-half mile of the trough.

The maximum relief in a NW-SE direction is 882', and the minimum in the same direction is 350'.

B. Topography

The general topography is a series of NW-SE trending ridges that rise gently to the SE. They are bounded on the SE by mountains rising on an average of about 500' above the uppermost elevations of the ridges.

The ridges of the S.W. sector of the area are separated for the most part by broad, smooth, stream valleys. Iron Canyon, Bee Canyon, and Oak Spring Canyon are good examples of this type of valley. In the NE portion of the area, the ridges are musch closer together, and are separated by deeply cut canyons. Stream dissection is quite prominent here, and several stream scarps are distinctly seen. Also, in the NE portion of the area the topography is almost of badland character, only the hills are more rounded than in a typical badland topography. Along the northern border of the area are two small islands surrounded by alluvium, that are in the stage of becoming completely submerged and eroded away. In the SW portion, the topography is a little more mild on a whole, yet in places assumes a certain degree of ruggedness. In the vicinity of Gorman Canyon, the topography is very rugged.

Collectively, the area appears to be in the early maturity stage of erosion, although the stream valleys give it the appearance of being much later.

C. Drainage

The Sand Canyon-Soledad Canyon area for the most part slopes toward the NW, except in the vicinity of Gorman Canyon where it slopes to the north. Hence, in the Gorman Canyon district the drainage takes place in northerly trending valleys that culminate in the Sand Canyon drainage.

In the remainder of the area, except in the vicinity of the previously mentioned trough, drainage takes place in gently dipping, north-westerly draining valleys, namely Iron Canyon, Bee Canyon, and Oak Spring Canyon. These main streams are fed by waters from roughly N-S trending gullies and shallow canyons. The drainage from Iron Canyon and Bee Canyon empties into N-S trending Sand Canyon, and Sand Canyon in turn empties into E-W trending Soledad Canyon. Oak Spring Canyon drains directly into Soledad Canyon, and Soledad Canyon thus carries the complete drainage to the west.

The trough at the head of the ridges, drains in both NE and SW directions, depending upon its proximity to other canyons. In the extreme north portion the trough drains to the north directly into Soledad Canyon. Where the trough crosses Oak Spring and Iron Canyons, the north lying portions drain southward and the south lying portions drain northward into these two canyons. The trough, incidentally, is much more accentuated and continuous at its NE end.

D. Vegetation

The vegetation for the most part is of the natural chaparral type, being typically semi-arid. There is a concentration of brush in most of the ravines, making it almost impenetrable. Trees are scattered throughout the valleys, and the southern part of the area is the richer in vegetation.

Some of the more numerous plants in the area are:

Live Oak--------------Quercus velutina

Scrub Oak-------------Quercus dumosa

Sycamore--------------Platanus racemosa

Manzanita-------------Arctosphylus manzanita

Yucca-----------------Yucca whippili

Thistle---------------Caarduus coulteri

Poison Oak----------------Rhus diversiloba

Brodiaea------------------Brodiaea congesta

E. Exposures

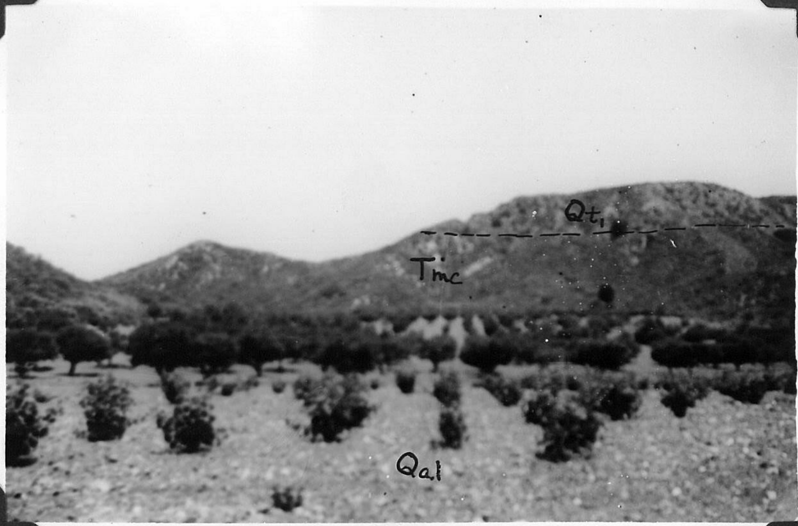
Exposures are rather plentiful in the area, but they are not all capable of giving reliable dips and strikes. This is because of the character of the rock exposed, which is mainly of conglomeratic materials or of sandstones that are not strongly consolidated along bedding planes.

Most of the outcrops are due to the stream valleys and to the narrow ravines. Differences in the degree of hardness of the strata members also leads to a good number of exposures on rather steep cliffs.

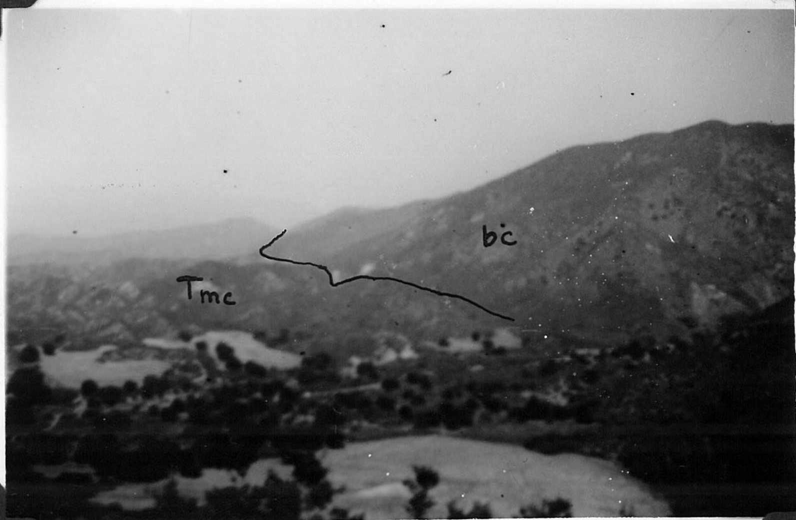
There is a good deal of float, particularly in the northern section, which tends to cover any natural outcrop.

Road cuts also give some very good exposures.

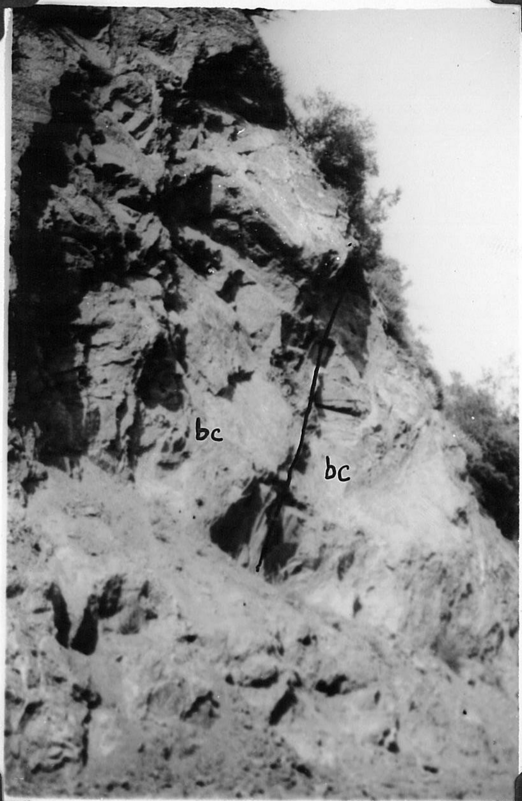
The Terrace gravels are more resistant than the older Mint Canyon formation, and form bluffs which give an excellent exposure of the bedding and rock character, as well as clearly showing the contact between the two types.



Looking NE at contact between terrace deposit and Mint Canyon Fm. in SW portion of area



On top of hill in top picture, looking NE along the La ng fault. Note scarp.



View of extremely complicated Basement Complex

Modelo outcrop

IV. A. Stratigraphy and Petrology

1. Regional

In considering regional stratigraphy and petrology, the discussion will be limited to the region south of Soledad Canyon.

The oldest rock in the region is a series of schistose beds, called by some the Pelona formation. It consists of quartizites, marble, slates, and phyllites. It has been intruded by a dioritic mass, causing great distortion of these older sediments. The Pelona schists are assumed by some as being pre-Paleozoic, and the intrusive is believed to be Jurassic.

The sedimentary series of unmetamorphosed rocks is restricted to Tertiary, there being present the Sangus, Pico, Modelo, and Mint Canyon formations. Of these, the Sangus and Mint Canyons are non-marine, and the Pico and Modelo are marine. The Mint Canyon is the oldest, being lower Upper Miocene. The Modelo is upper Upper Miocene, the Pico is Lower Pliocene, and the Sangus is Upper Pliocene. There are also some terrace deposits, of Late Pleistocene age.

The sedimentary series collectively consists of sandstones, conglomerates, shales, arkosic materials, silty beds, and some volcanic ash beds. The terrace deposits for the most part are of heavy conglomerates.

The thicknesses of the formation are-Mint Canyon, 4000'; Modelo, 9,000'; Pico 4000', Sangus, 2000', and Terrace deposits, 250'.

2. Local

Basement Complex: The basement complex in this area is a complicated mass of schistose rocks, having been intruded by a large body of diorite. The schistose rocks are apparently quite old in age, and are claimed by some to be a part of the Pelona schist series. They consist of dark colored, grayish quartzizites, and in this particular area there is little bedding seen. Some slaty beds also appear, and for the most part these resemble phyllite much more than a true slate. They are grayish in color, and fracture into thin, irregular slabs. There are several conglomeratic metamorphosed beds present, and occur massively. The rock components of these former conglomerates are rather small, being on the average 1" to 2" in size. No bedding planes are seen in these. A bed of mica schist was found, the schist being blackish in color. The mica flakes were all quite small, but showed a definite orientation. The metamorphic series for the most part is steeply dipping. In the vicinity of Bear and Coyote Canyons they dip in the neighborhood of 60°-70°. Intruding this metamorphic series is a large body of diorite, of Jurassic age. The diorite has weathered considerably, and in some places its color index is such that it appears to be almost gabboric. The mineral constituency of the diorite is mainly plagioclase and hornblende, and is unique in that it has a high content of ilmenite and magnetite. Evidently as stringers from the diorite intrusion are small aplite bodies, which for the most part outcrop in plug-like form, having a maximum surface exposure of about 60 square feet. These "plugs" outcrop in the schist series, and have also suffered considerable weathering. In the schists surrounding the "plugs" there may sometimes be seen small, almost embryonic garnet crystals. More recent plutonic activity is evidenced by the presence of quartz dikes which pass through both the schist series and the diorite. The quartz veins are of a type of milky quartz with limonite stainings, and are mostly in the range of 3" to 4" wide. Evidently these dikes are to a limited extent auriferous, for there are several abandoned mines that have worked the veins.

Mint Canyon Formation

The Mint Canyon formation is a fairly thick non-marine series (4000'?), of lower Upper Miocene time. For the most part, the series here is not very well consolidated, except for a few sandstone, conglomerate, and shale members. Many of the beds appear to be lenticular.

A detailed section was impossible because of the softness of some of the beds which has caused some slippage and hence deranging or covering over the true dip and strike. A general section is however possible. The base of the formation is nowhere exposed.

The lowermost exposures consist of fine grained grayish sandstones, gray clays, and light colored silt beds. The sandstone is not very thinly bedded, the alternate series being from 6" to about 30' in thickness. These sandstones are fairly resistant, and still exhibit quite well their bedding planes. The clay beds vary in color from a bluish color to a dull white. They are very fine grained, but are very soft. They have very little resistivity against weathering, and nowhere show their bedding. They invariably have slump areas, and are in unconsolidated masses. The silt-like beds likewise are poorly consolidated, and are quite susceptible to erosion. Interbedded with these materials are some thin conglomeratic lenses, which are composed of pebbles and small rocks up to 6" in diameter.

The middle part of the formation consists in the main of conglomerates and sandstones. The series, in general, tends to go from gray-yellow conglomerate to gray sandstone to gray conglomerate to silts and clays to yellow sandstone and yellow conglomerate. The lowest conglomerate of this middle portion contains boulders up to 18" in size, and these boulders are more or less laid along bedding plains. Between the rows of boulders are smaller pebbles and sandy materials. The rock components of this series is mainly from previous schists, gneisses, and granitics. The gray sandstone is not very well exposed, but where it is, it shows very good bedding. The individual bedding in this sandstone is around 3" wide, and is frequently stained with limonite. This gray conglomerate is an interesting bed. Bouldersin it are up to one foot in diameter, and are for the most part of previous sandstones. These boulders serve as a very good marker for this bed because of their character of weathering. The boulders are made of well bedded sandstones, and have become rounded during their transportation to form the conglomerate. Now, on being exposed to weathering, they tend to break along their own bedding planes, thus forming a series of disc-like slabs. The silts and clays that follow are similar to those previously mentioned, and occur in beds 10'-20' thick. The yellow sandstone is a very massive component, and is quite coarse grained. Its individual bedding planes are sometimes several feet apart, and along these planes frequently occur small pebbles in the magnitude of 1"-2". The sands are mainly of quartz and feldspar content, with some mica and hornblende (?) present. These beds are quite resistant, and in some places form steep bluffs. The yellow conglomerate occurs as a massive bed, with little or no sorting whatsoever. The bed appears to be yellow because of its ground mass, and because most of the boulders are either whitish or stained with limonite.

The upper part of the Mint Canyon formation as exposed in this area is of silts, clays,arkosic sandstones, and whitish conglomerates. The silts and clays here comprise a much greater thickness than in the lower portions, yet still suffer considerably from erosion. These beds are mostly of a grayish color, with some interbedded white strata. The arkosic sandstone occurs rather massively, and has thick individual beds of 2'-3' in thickness. This sandstone is rather coarse grained. The white conglomerate is also massive, showing little or no bedding, The boulder components are mainly of light colored granites and some gneisses and old quartzites.

There are frequent lenses in the Mint Canyon formation, and are usually of limited extent. They are of conglomerate, clay, and sandstone layers, and are scattered rather consistently through the area. A very good conglomerate lens may be seen by the junction of the Sand Canyon-Coyote Canyon roads. This conglomerate is brownish in color, and has boulders of granite, gneiss, schist, and hornblende porphyry that are 6" to 1' in size.

Collectively, the Mint Canyon formation in this area is of softer materials than on the north side of Soledad Canyon. Hence, badland topography is a little more limited here, as the soft beds tend to form rounded slopes.

Modelo Formation

The Modelo formation as exposed in the area has a thickness of around 225', and occurs only in the south west portion between Gorman and Reynier Canyons. This formation has good outcrops, because it forms sort of a butte, having steep walls which expose the formation clearly. The rock is evidently thus rather resistant to erosion.

The Modelo here consists of thin sandstones, thinly bedded siliceous shales, and some diatomaceous shales. The lower part as exposed here consists of thinly bedded buff sandstones, which are around 3" thick. Overlying these are siliceous shaly members, intermingled with thin, platy shales. Many of these thinly bedded shales are stained with limonite. The lowermost part of the formation shows cross-bedding on a very extensive basis. Some of the lenses thus formed vary around 30' in length and about 5' thick. There is a slight erosional unconformity between the sandstone and the shale members.

Near the top of the butte, some fossils were found in the siliceous shales. They were of the Super-Family Pectimacea. These fossil forms were not very perfect, but were recognizable as far as a Super-Family classification. The Modelo is thus a marine series, of upper Upper Miocene, as evidenced by its fossil content.

Terrace deposits

There are two sets of terrace deposits in the area, namely that which is very ferruginous and that which is sandy.

The red-brown ferruginous gravels occur in the southern part of the area, and overly unconformably the Mint Canyon formation. These gravels are extremely well consolidated, having been cemented with limonite and carbonates. The gravels here are much better consolidated than the underlying Mint Canyon, and tends to form steep cliffs around its borders. The maximum thickness here is about 120'. A rude stratification may be seen, in which boulders are fairly well aligned. The boulders are on the average around 2"-6" in size and are rather well rounded. They are mainly of gneiss, diorite, schist, and some quartzite. Occasionally in this terrace deposit are found small areas which appear to be almost solely of limonite. The limonite which colors this deposit so deeply probably originated from the magnetite and ilmenite of the basement complex diorite. The magnetite and ilmenite were probably deposited as such, and later they underwent alteration to the present limonite. This deposit is presumably of Upper Pleistocene.

The second type of terrace deposit is that which may be seen in the road cut on the Sand Canyon road just south of the railroad bridge. There is some question as to whether or not this is terrace material, but for several reasons I have classified it as such. The beds all have a dip of around 3, are poorly consolidated and lie unconformably upon the Mint Canyon. The contact looks like a fault contact, but because of lack of drag, absence of gouge or breccia, and lack of topographic expression, this theory was expelled.[1] This deposit I believe to have arisen[2] by means of a slow moving stream, and was probably a small embayment where the stream widened. The deposits resemble very closely that type which may be seen in the narrow ravines of the present flood valleys. The character of this terrace deposit is that it is of rather coarse sandy material, with thin layers of small pebbles in it. The pebbles are mainly of granitic rocks, and are well rounded for the most part.

The recent alluvium fills the broad valley floors, as well as the small stream channels. It is all unconsolidated material, varying from silts to coarse conglomerates. Black sands, composed of magnetite and ilmenite, are scattered throughout the stream channels, and in some places have aggregated to a thickness of about six inches.

B. Geologic Structure

1. Regional

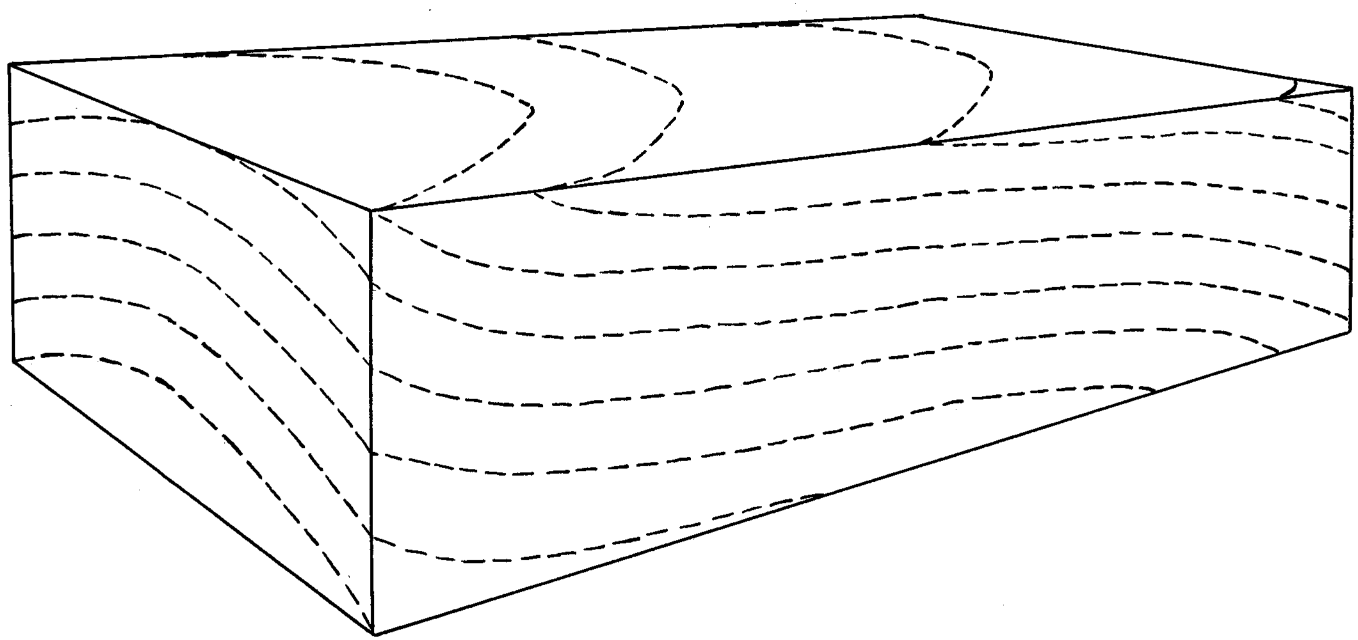
Considering the regional structure to be limited to the area north and south of Soledad Canyon from Lang to Sangus, the dominant structural feature is a series of Tertiary sediments that regionally, have a strike of about N20°E, and dip on the average about 20°N. The sediments to the east of Solemint are mostly of the Mint Canyon formation, and tend to be somewhat monoclinal in the general vicinity of Lang. There are some smaller folds, as well as numerous faults, in the sediments. To the south and east, the sediments are faulted against the basement complex in a system of normal faults, namely the Soledad Canyon fault, the Lang fault, and the San Gabriel fault. The San Andreas fault to the east, as well as these smaller faults, probably had considerable effect in producing the strains and stresses that produced the folding and faulting of the sediments.

2. Local

The local structure may be divided into three sections-the area between Soledad and Oak Spring Canyons, the area between Oak Spring and Sand Canyons, and the area between Reynier and Bear Canyons.

The dominant feature of the area as a whole is the Lang fault, which has an approximate strike of N26 E, and forms the Mint Canyon-Basement Complex contact between Soledad and Sand Canyons. The fault itself has a rather steep dip of about 75°N, and the SE side has moved up with respect to the NW. The basement itself forms a distinct scarp along the fault, which rises several hundred feet above the Mint Canyon formation. This scarp does not represent the original fault surface, but is the erosional product of it. This scarp has a northward dip of around 35°. Along the scarp, a great number of triangular facets exist, and these are now in the process of being eroded down. A small zone of fault gouge and breccia was found, and the gouge itself was very platy. In conjunction with the faulting, the Mint Canyon formation shows the effect of drag near the contact. The beds dip from 20° N to 30° N on approaching the fault, and then suddenly undergo a change of dip which attains an angle of about 50° at the contact.

Block Diagram Showing Structure of Mint Canyon Formation in the Area between Oak Spring and Soledad Canyons. (Accentuated)



The Mint Canyon formation considered on a regional basis strike about N25 E, and dip to the north with an angle of 25 -50 . Along the strike, however occur fluctuations, which give a plunging structure to the area.

In the region between Soledad and Oak Spring Canyons, the structural feature is a broad, very gentle anticline. This is a slight warp along the strike of the beds, and is imperceptible except by judging from the dips and strikes that were taken. Also, the anticline is monoclimal parallel to its axis. The anticline as a whole plunges to the west. In a time relationship, the warps probably occurred either before or coincidental with the monoclinal folding.

In the region between Oak Spring Canyon and Sand Canyon, the area is practically void of structure except for a few minor faults. The sediments have a nearly constant dip of around 35 N, except for a steepening at the basement contact. Two faults are clearly seen in the road cut on the Sand Canyon road just south of the railroad bridge. The faults here are about 15' apart, and are practically vertical. These are strike slip faults, with a slight vertical movement of around 5', as measurable in the road cut. The north side moved upward with respect to the south in both cases. The age of the faults is probably Pliocene. A third fault occurs about midway up the ridge between Oak Spring and Bee Canyon. This fault is recognized by a change of dip in the beds, a lined series of saddles, and the occurrence of several springs along the strike of the fault. This appears to have been a strike slip fault with a slight rotational movement: the W side moving north with respect to the east for a distance of at least 20'. The north end of the east side probably went up with respect to the north end of the west side. This fault was probably also of Pliocene time. In the north portion of the area, the terrace gravels occur. These are situated on top of the Mint Canyon formation, and are separated by a distinct angular unconformity. The terrace deposits dip about 3 N. The line of unconformity follows that of the dip of the terrace gravels.

In the area between Reynier and Gorman Canyons, a syncline in the Modelo and Mint Canyon formations occur. The Modelo overlies the Mint Canyon in an unconformity. The syncline occurs through a small butte, and plunges to the north-east. The syncline is a marked one, having dips up to 30 in both directions along the limbs of the syncline.

A fault also runs to the east of Bear Canyon, and probably intersects the Lang fault under the Mint Canyon. This fault is quite old, confined to the basement, and has a gouge and breccia about 2' wide. The fault is predominantly strike-slip, with the

Sw side moving SE with respect to the NE side. A fault also runs up Coyote Canyon, and forms the contact between the Mint Canyon and Basement Complex, as well as continuing into the latter. The Lang fault prolongs itself up Gorman Canyon. Striking about N60 E is a fault which is exposed in Bear Canyon and from there passes west to Gorman Canyon. This fault, as well as the Coyote Canyon and Lang faults, probably occurred in Pliocene time. The Mint Canyon in this general region strikes roughly parallel to the fault, and shows a little evidence of drag. Just N of hill 2630 is another fault, striking E-W. This fault has both strike slip and dip slip movement, the south side moving up and west with respect to the north. Several other faults are included in this general locality, and as a result this region is fairly complicated. The general sequence of faulting here was-(1) the Bear Canyon fault, (2) the Lang and Coyote Canyon faults, (3) the contact fault, and (4) the fault in hill 2630.

V. HISTORICAL GEOLOGY

Assuming that the metamorphics are pre-Paleozoic, the geologic history of the region began at that period with their deposition as sediments. These sediments were laid down in a shallow basin, in the form of sandstones and shales.

With all probability, the Paleozoic saw further deposition in this region, followed by a subsidence of the sea, and an elevation of the land. Erosion stripped off some of the overlying strata, and subsequently in Jurassic time there was an intrusion of the dioritic mass, and its aplite dikes were shot through the massive metamorphics. This intrusion coupled with pressure from above, served to metamorphose these sediments through a long range of geologic time. Later, somewhere probably in the early Tertiary, the dioritic mass and the metamorphics were subject to penetration by a series of quartz dikes. Following this, there was faulting in the now Basement Complex, as exemplified by the fault in Bear Canyon.

In Upper Miocene time, in this same depositional area, the Mint Canyon formation was deposited under similar conditions. This shallow basin was from time to time subjected to torrential inflows, and variations of current produced the cross-bedding. Later this lake subsided, and there was again a period of erosion, during which the formation was tilted somewhat and folded. Then later in Upper Miocene time, there was an inflow of the sea, and the marine Modelo formation was laid down.

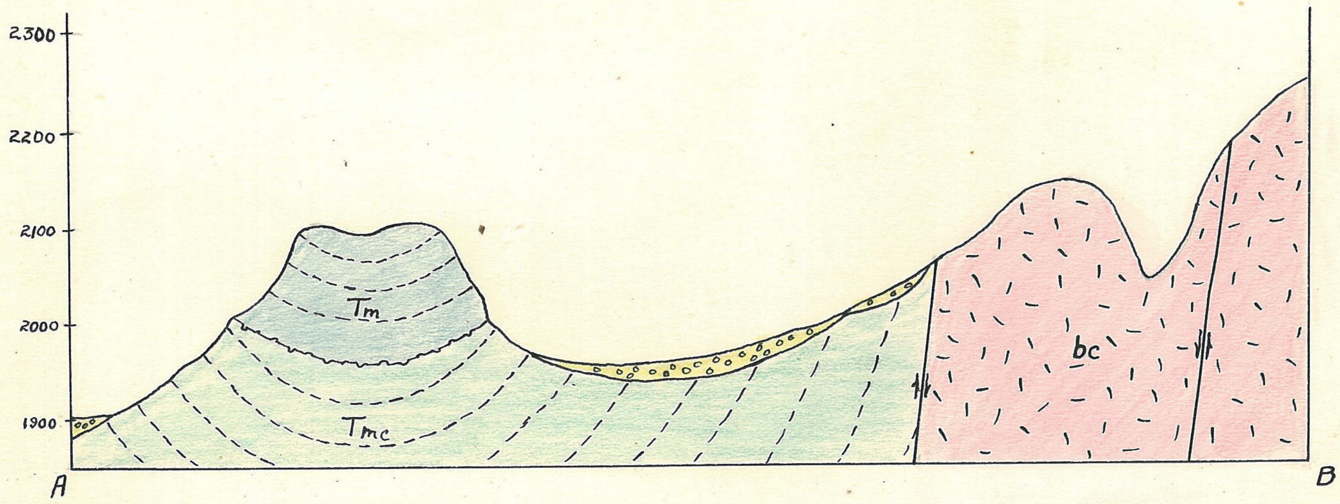
In Pliocene time, there was again an elevation of the land, followed by further folding and faulting. At this time, the Lang, Coyote Canyon, and contact faults probably occurred, tilting and folding the Mint Canyon and Modelo formations to a higher degree. Also, the old schists and diorite were brought to the surface, to form the rugged mountains to the south-east.

In Pleistocene time, the faults in the Mint Canyon formation occurred.

In Late Pleistocene, the region had in parts again been submerged, and the terrace gravels were deposited.

Following this, there was a withdrawal of the bodies of water from the area, and erosion once more began.

This erosion has continued until the present day with very little fault movement since, as may be concluded from the dip of the terrace deposits. Erosion has eaten back the soft Mint Canyon, and formed the broad inter-ridge valleys. Small ravines in these valleys have hinted a further uplift of the area, but it is not certain. They may have arisen during years of heavy rainfall.



Scale legend etc.